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THROTTLE VALVE

TECHNICAL FIELD

The present invention relates to a throttle valve for the air/fuel intake of an internal combustion engine. The present invention is described with reference to a rotary valve internal combustion engine, however, it should be understood that the present invention is suitable for use with any internal combustion engine that requires a throttle valve.

BACKGROUND

The majority of vehicle internal combustion engines utilise a butterfly throttle valve to control air/fuel intake. Whilst butterfly throttle valves are of a relatively simple and inexpensive design, they have a number of disadvantages. Firstly, when a butterfly throttle valve is fully open, ie. at full throttle, the butterfly still restricts the fluid flow. This restriction at full throttle impedes engine performance, where the obstruction of the fully open butterfly, impedes the fluid flow entering the engine.

Another disadvantage of a butterfly throttle valve is its length. Butterfly throttle valves are not suitable for placement very close to the cylinder head, because the butterfly will interfere with the inlet port, as well as impede the fluid flow into the inlet port. This is most disadvantageous on high speed engines, where the length of the inlet tract (L_1 in FIG. 1) must be small to maximise engine performance at higher engine speeds. The higher the speed of the engine the smaller the required inlet tract length. The axial length occupied by the butterfly limits how short the inlet tract may be made and hence the maximum speed at which the engine can operate efficiently.

Furthermore, unlike poppet valve engines using four valves per cylinder, rotary valves have a single very large diameter inlet port. Such an inlet port requires a corresponding large diameter butterfly, which occupies a large axial length, thus further restricting the designer's ability to provide a short inlet tract length. This is a major problem on rotary valve engines where the butterfly must be located upstream of the rotating valve. This is particularly the

case, as the inlet port in a rotary valve is constrained, by mechanical considerations, to be relatively long compared to the inlet port on a poppet valve.

Slide (or guillotine) throttle valves are also common place on many high performance engines and provide an unobstructed flow to the inlet of the cylinder when at fully open throttle. As the length of slide throttle valves in the flow direction, is smaller to than that of butterfly throttle valves, they can be used in configurations where it is desirable to minimise the inlet tract length. However, the main disadvantage to this type of throttle valve is space required to accommodate the sliding movement of the throttle plate between the open and closed position. In multicylinder engines, where the cylinder centres are close together and the inlet ports have large cross sectional areas, there is insufficient space between the cylinders to accommodate the required throttle plate movement. Also, slide throttle valves are prone to bind or seize and may require extra maintenance.

On high performance poppet valve engines this problem has been addressed, in recent times, by the introduction of barrel throttles. This arrangement consists of two barrels geared together. A portion of the outside diameter of both these barrels is removed such that when they are rotated to the full throttle position, they provide an obstructed flow path for the inlet air and fuel. This arrangement is particularly suited to poppet valve arrangements incorporating four valves per cylinder. Such engines have two inlet ports of relatively small diameter, which generally merge into a single oval shaped port adjacent the barrel throttle. As the oval shaped port has a low height, small diameter cylinders can be used for the barrel throttle. These small diameter cylinders occupy greater length in the flow direction than a slide throttle but less length than a butterfly throttle.

Another type of throttle valve is shown in US Patent No. 5,662,086 (Piccinini). It describes a throttle valve that comprises a tubular elastic material mounted in the main air/fuel intake duct of an engine. Tubular elastic material is transversely acted upon by at least one pair of movable blades choking the elastic material in a perpendicular direction relative to the axis, thereby

forming a constriction and throttling action. Like the above mentioned slide throttle valve, this type of throttle forms an unobstructed "full open" throttle condition, but disadvantageously occupies substantial length in the flow direction similar to the butterfly throttle valve. Furthermore, the durability of the elastic material would be questionable, especially when the vacuum pressures of an internal combustion engine are considered.

The present invention seeks to overcome the disadvantages associated with the above mentioned prior art throttle valves.

SUMMARY OF INVENTION

According to a first aspect the present invention consists in a throttle valve for an internal combustion engine comprising an aperture adapted to be variably opened and closed between a first fully opened configuration and a second closed configuration, wherein at said first fully opened configuration the central region of the aperture is unobstructed to axial fluid flow, characterised in that said aperture is variably opened and closed by a plurality of substantially coplanar plates mounted about the periphery of said aperture and movable towards the central region of the aperture.

Preferably said aperture is substantially circular.

Preferably each of said plates is pivotally mounted.

Preferably the overall length of said throttle is substantially small compared to the diameter of said aperture.

Preferably each said plate is beak shaped having a concave edge and a convex edge meeting at a tip.

Preferably said concave and convex edges are substantially equal in radius of curvature.

Preferably movement of said plurality of substantially coplanar plates are actuated by an actuator ring to move said plates simultaneously.

Preferably said throttle valve is used for either air or an air/fuel mix.

Preferably said throttle valve may be used on a rotary valve internal combustion engine.

In another embodiment, said substantially coplanar plates have overlapping portions.

According to a second aspect the present invention consists in a rotary valve internal combustion engine having a throttle valve comprising an aperture adapted to be variably opened and closed between a first fully opened configuration and a second closed configuration, wherein at said first fully opened configuration the central region of the aperture is unobstructed to axial fluid flow, characterised in that said aperture is variably opened and closed by a plurality of substantially coplanar plates mounted about the periphery of said aperture and movable towards the central region of the aperture.

BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 is a cross-sectional view of a prior art butterfly throttle valve located near the inlet port of a rotary valve engine.

Fig. 2 is a cross-sectional view of a throttle valve of the present invention located near the inlet port of a rotary valve engine.

Fig. 3 is an elevational view of the throttle valve shown in Fig. 2 in a fully open configuration.

Fig. 4 is an elevational view of the throttle valve shown in Fig. 2 in a two-thirds open configuration.

Fig. 5 is an elevational view of the throttle valve shown in Fig. 2 in a one-third open configuration.

Fig. 6 is an elevational view of the throttle valve shown in Fig. 2 in the closed configuration.

MODE OF CARRYING OUT THE INVENTION

Fig 1. depicts a prior art butterfly throttle valve 8 located on a rotary valve internal combustion engine comprising a cylinder head 2, cylinder 3, rotary valve 4 and a piston 5. Rotary valve 4 having an inlet port 6 in fluid communication with window 13 in cylinder head 2. Air and fuel passes through window 13 into cylinder 3 during the induction stroke.

In applications requiring short inlet tracts it is necessary to position the butterfly as close as possible to the rotating valve. A butterfly located close to the rotary valve interferes with the fluid flow through the inlet port and with the pressure waves which traverse the inlet tract and which are essential for optimum engine breathing.

FIG. 2 depicts a throttle valve 1, located on a single cylinder rotary valve internal combustion engine comprising a cylinder head 2, cylinder 3, rotary valve 4 and piston 5. Rotary valve 4 having an inlet port 6 in fluid communication with window 13, in cylinder head 2. Throttle valve 1 regulates the fuel/air mix flow into cylinder 3.

Throttle valve 1 is mounted adjacent to inlet port 6, utilising a flange mounting means (not shown). The length L of throttle valve 1 is substantially smaller than the valve aperture diameter D. When throttle valve 1 is fully open it is free from obstruction to the fluid flow, thereby allowing the use of very short inlet tracts required on high speed engines.

FIGS. 3-6 show throttle valve 1 in four different opening configurations, "fully opened", "two-thirds open", "one-third open" and "closed". Throttle valve 1 has six substantially coplanar "beak shaped" plates 10, disposed about the outside of the periphery of circular aperture 9. Each plate 10 has a tip 19, a concave edge 20, and a convex edge 21. The radius of curvature of each concave edge 20 and convex edge 21 is substantially equal to the radius of curvature of the periphery of circular aperture 9.

Each plate 10 is pivotally mounted about a respective fixed pin 14. The fixed pins 14 are equally circumferentially spaced apart and are mounted to an annular mounting plate 15, or base plate 19 (FIG. 2) or both.

Each plate 10 has an arcuate slot 16 and short straight slot 17. Each plate 10 is constrained to pivotal movement about its respective fixed pin 14.

An actuator ring 11 has six actuator pins 18 fixed thereto and are circumferentially equally spaced apart to each other. Each actuator pin 18 is engaged with a respective straight slot 17 of a plate 10. Rotational movement of actuator ring 11 as shown by arrow A, simultaneously moves all six plates

10 about their respective fixed pins 14, such that tip 19 of each plate 10, moves inwardly into circular aperture 9 progressively closing valve 1.

Movement of "beak shaped" plates 10 varies the state of throttle valve 1 from a fully open configuration (see Fig. 3) to a closed configuration (see Fig. 6). In the closed configuration, a small substantially hexagonally shaped central region 12 of the aperture 9 is provided to allow enough air/fuel mix to maintain the engine at an idle state.

Fig. 4 depicts throttle valve 1 in a two-thirds open configuration, and Fig. 5 depicts valve 1 in a one-third open configuration.

Rotational movement of actuator ring 11 in a direction opposite to arrow A, will progressively open valve 1. In the fully open configuration of valve 1 as shown in Fig. 3, all six plates 10 withdraw from aperture 9 such that their respective concave edges 20 align with the outer circular periphery of aperture 9. In this fully open configuration, there is no obstruction to air/fuel flow.

The throttle 1 has a similar length in the fluid flow direction as previous slide valves. However, compared to the slide valve it requires less space perpendicular to the fluid flow direction. This means it is suitable for installation on multicylinder engines with smaller cylinder centre distances typically found on modern IC engines.

Thus, throttle valve 1 of the above described embodiment, has the following advantages. Firstly, it provides a completely unobstructed and non-directed fluid flow path that is not achievable with prior art butterfly valves. Secondly, it has the advantage of compact space configuration outside the circular aperture 9 not achievable with prior art slide valves and that of the valve described in US Patent No. 5,682,082 (Piccinini). Thirdly, its small length in the fluid flow direction allows the use of short inlet tracts not achievable with butterfly or barrel valves, particular when applied to rotary valve engines. This makes the above described embodiment of the present invention, advantageous for high-speed engines, such as competition engines.

It should be understood that the reciprocal rotation of actuator ring 11 to variably open and close throttle valve 1, may be achieved by any suitable

actuation mechanism, such as a biased mechanical cable, hydraulic or electric motorised actuator.

It should also be understood that in another not shown embodiment, plates 10 may have concave and convex edges having radii of curvature that are not substantially equal to that of the circular aperture 9. In such an embodiment plates 10 may have to withdraw past the outer periphery of the aperture 9 to allow an unobstructed "fully open configuration" of valve 1.

In the above described embodiment, the fuel delivery means is not shown. It should be understood that the fuel delivery means may deliver fuel before or after throttle valve 1. In the case of a direct injection internal combustion engine, throttle valve 1 may be used only for air.

In the embodiment where the fuel delivery means delivers fuel and air before throttle valve 1, it should be understood that tip 19, and concave and convex edges 20, 21 of each plate 10, may assist in the mixing of the fuel and air when throttle valve 1 is partly opened, such as depicted in Figs. 4 and 5.

Whilst the description of the above referenced embodiment refers to "substantially" coplanar plates 10, it should be understood that this terminology includes plates 10 that are near coplanar and in some instances overlap. Furthermore, it should understood that the terminology of "closed configuration" includes configurations where the plates 10 are nearly or substantially closed.

In another not shown embodiment, the plates 10 may be configured in such a manner that in a "closed configuration", they close leaving no region 12 as shown in Fig. 6. In this case, idle is maintained by leakage of air and fuel through the small gaps that occur where the plates abut each other.

It should also be understood that whilst the above described embodiment of the present invention is particularly suited to use with a high speed rotary valve competition engine, the throttle valve of the present invention may be used with any internal combustion engine.

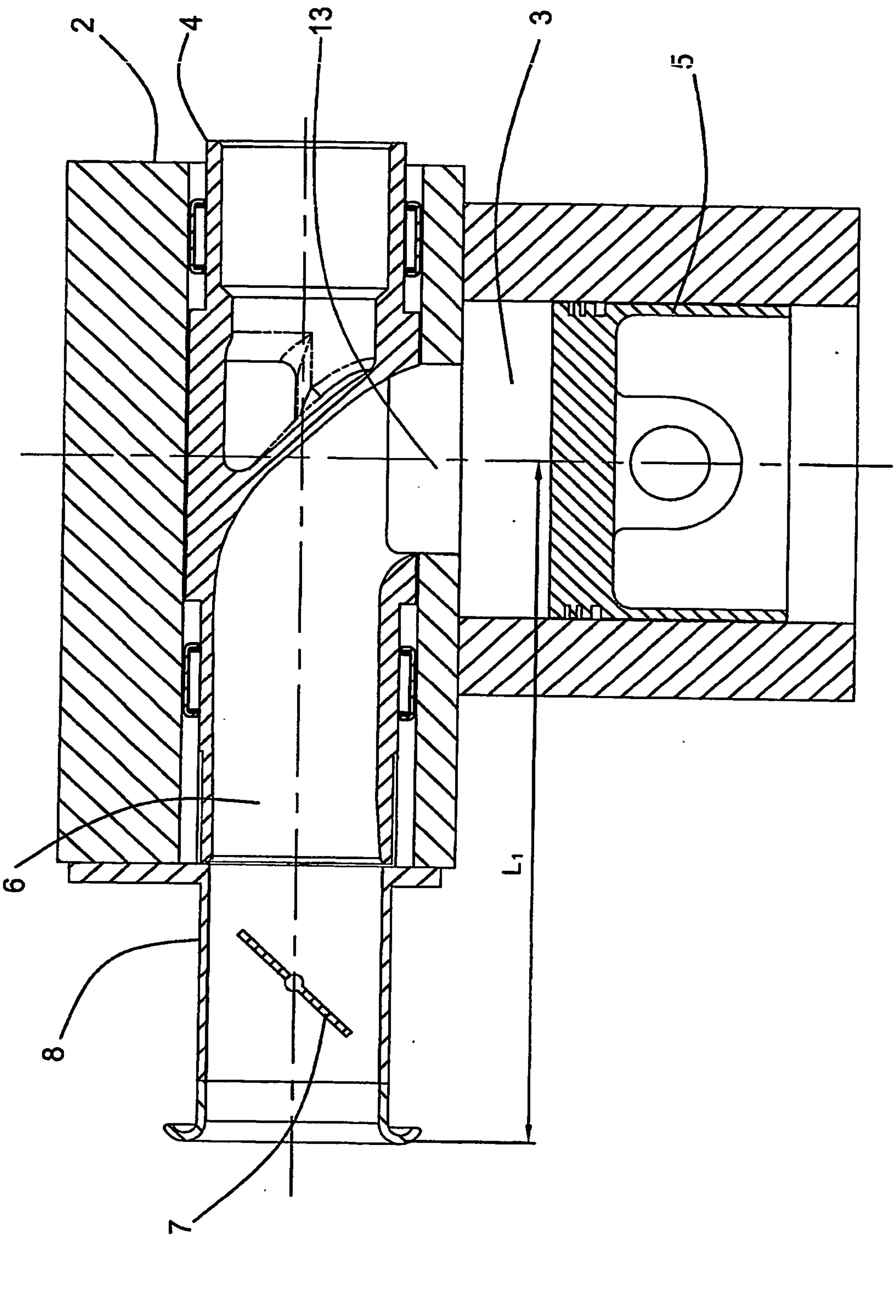

FIG 1.

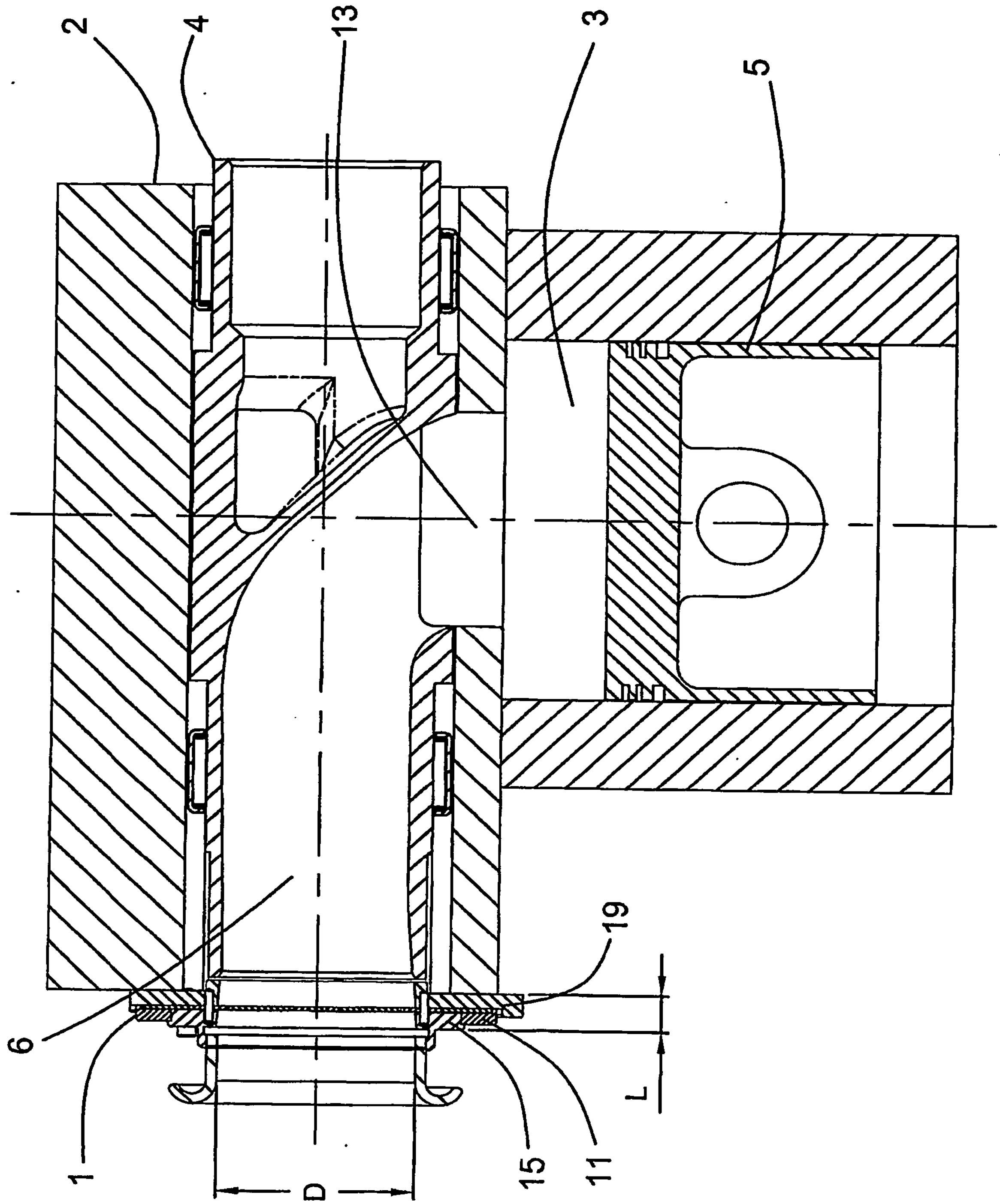

FIG 2.

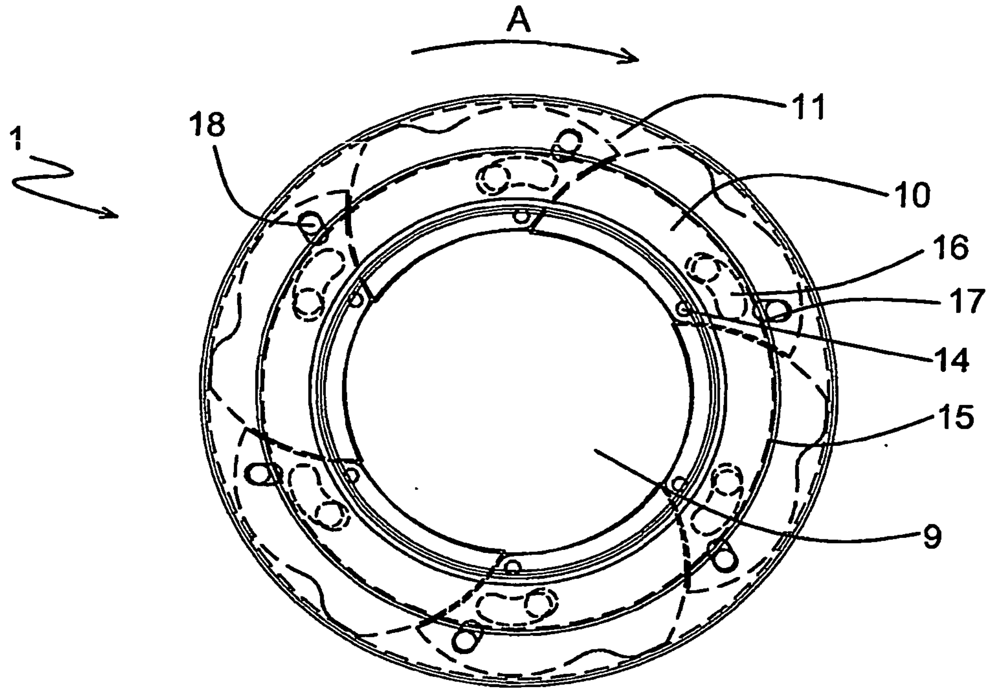

FIG 3.

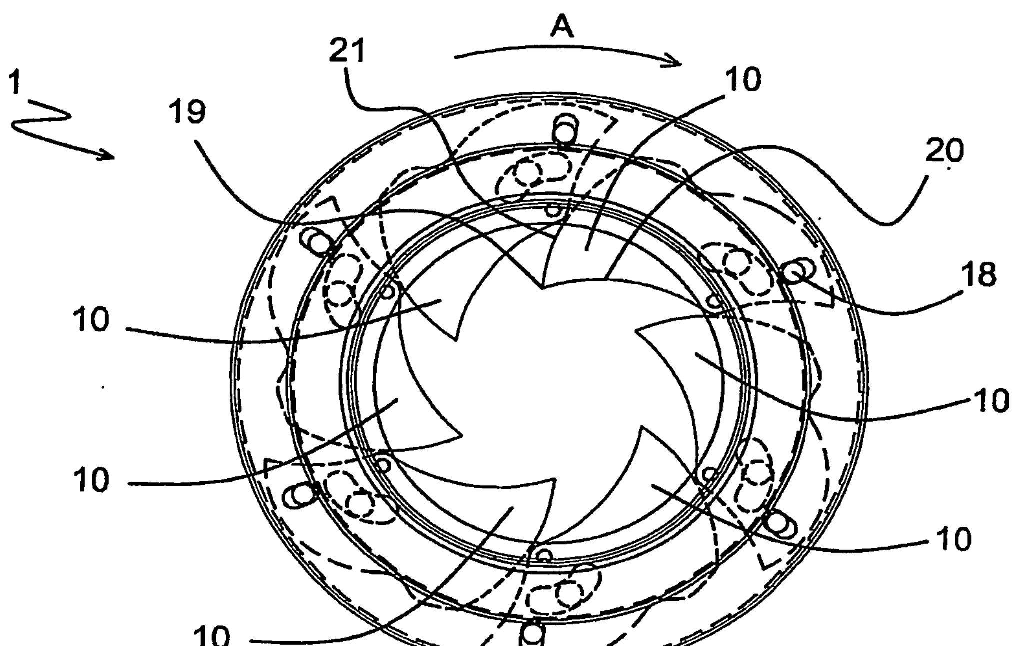

FIG 4.

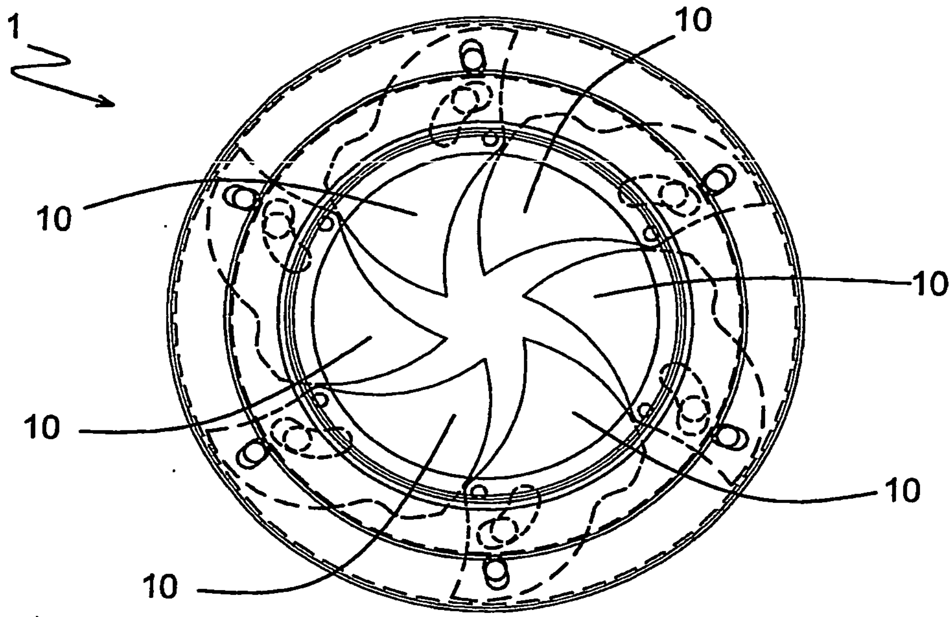

FIG 5.

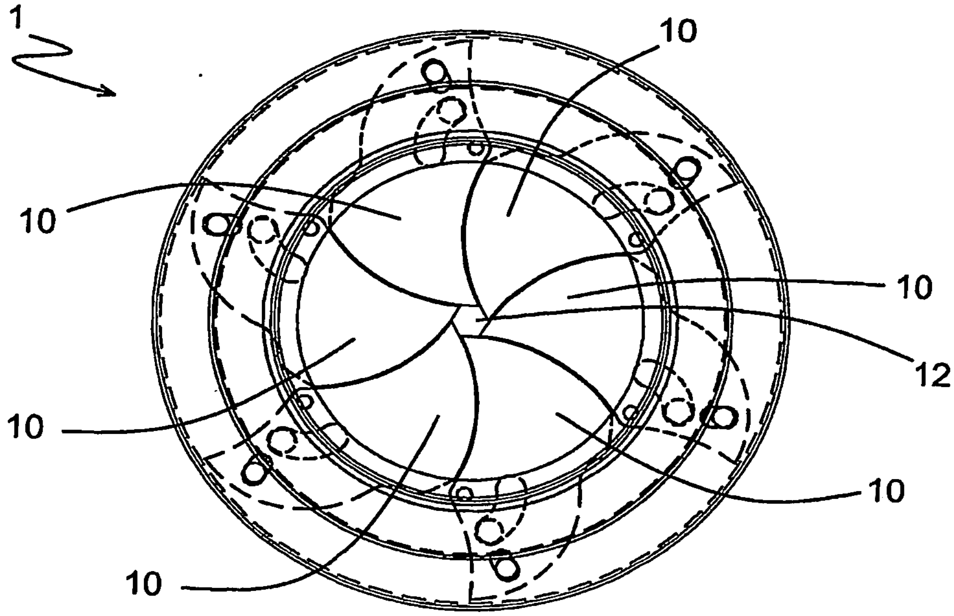

FIG 6.